

Billions Without Detection: A Financial and Scientific Reassessment of Dark-Matter Research

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Abstract

For more than four decades, governments around the world have invested billions of public dollars in the search for particle dark matter. Despite the construction of large underground detectors, multi-ton noble-gas chambers, deep-space missions, and extensive cosmological surveys, no dark-matter particle has ever been detected. This article presents the most conservative quantitative reconstruction to date of global public spending on dark-matter research, revealing a cumulative investment of approximately \$3–6 billion since 2000, with annual expenditures in the range of \$300–600 million.

In parallel, we evaluate whether this sustained investment is scientifically justified given the absence of empirical confirmation and the existence of predictive, falsifiable alternatives. Within this context, we highlight the Quarkbase Cosmology framework—an etheric pressure-field model capable of reproducing flat galactic rotation curves, the geometry of galaxies, and the large-scale cosmic web without invoking undetected matter.

By comparing the financial structure of the dark-matter program with the empirical performance of both paradigms, we argue that the continued expansion of particle-dark-matter budgets lacks proportionality and transparency. We propose concrete policy measures for rebalancing global research funding, including the redirection of 10–20% of current dark-matter allocations toward alternative theoretical frameworks capable of competing on empirical grounds.

The aim is to reintroduce scientific pluralism, restore empirical accountability, and ensure that public resources support a diverse and evidence-driven exploration of cosmic dynamics.

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1 Introduction

1.1 The Global Cost of Dark Matter Research and the Case for Alternative Physical Frameworks

1.2 Introduction

For more than four decades, governments around the world have invested heavily in the search for particle dark matter. Large underground detectors, multi-ton noble-gas chambers, deep-space missions, and cosmological surveys have been justified under the assumption that an invisible, non-baryonic form of matter must exist to account for galactic rotation curves, gravitational lensing, the formation of the cosmic web, and the statistical regularities of the Cosmic Microwave Background.

Yet, despite *billions of dollars* in public investment, **no dark-matter particle has ever been detected.**

This raises a scientific and socioeconomic question that is becoming increasingly difficult to avoid:

How much public money has been spent on the dark-matter hypothesis, and is the continued financial expansion of this program justified if alternative frameworks can reproduce the same phenomena without invoking undetected matter?

The present work addresses this question in two stages:

1. **A quantitative assessment** of global public spending on dark-matter research, including direct detection experiments, space missions, astrophysical surveys, data-analysis budgets, laboratory operations, and long-term infrastructure costs.

2. **A comparative scientific perspective** showing that several key empirical phenomena traditionally attributed to dark matter —galactic rotation curves, the geometry of galaxies, and the large-scale distribution of clusters and superclusters— can be derived naturally from the **Quarkbase Cosmology** framework, a frictionless-ether model developed in recent years (Omeñaca Prado 2025).

- Large-scale cosmic structure as interference patterns of the Ψ -field
- Flat galactic rotation curves via Yukawa-screened pressure fields, without halos

This dual analysis allows a broader and more responsible scientific conversation about whether the continuation of multibillion-dollar programs with no empirical success remains justified, or whether theoretical alternatives deserve proportional attention and funding.

2 The Hidden Financial Cost of the Dark-Matter Paradigm

2.1 A Global Program Without a Single Confirmed Particle

The search for dark matter has grown into one of the most expensive scientific enterprises of the 21st century. The scale is rarely discussed explicitly: budgets are fragmented across agencies, countries, and infrastructures, making the total cost effectively invisible to the public. Yet, when the numbers are consolidated, a clear picture emerges:

- **No dark-matter particle has been detected** in over 40 years.
- **Dozens of experiments** have been constructed, upgraded, decommissioned, and rebuilt.
- The **annual public investment** now reaches *hundreds of millions of dollars*.
- The **cumulative global investment** plausibly exceeds *several billions*.

The lack of a consolidated financial overview has allowed the field to continue expanding without systematic scrutiny. This article attempts to quantify that investment, to the extent publicly recorded budgets allow.

2.2 Fragmentation of Funding Sources

There is no single “dark-matter budget.” Instead, funding is distributed across:

- National laboratories (DOE, NSF, STFC, INFN, CNRS, DFG, JSPS, CAS).
- Underground facilities (LNGS, SNOLAB, CJPL, Boulby).
- Space agencies (NASA, ESA, CNSA).
- University consortia and institutional grants.
- Large infrastructure contributions (e.g., the Vera C. Rubin Observatory).

- Mission-specific allocations (e.g., ESA Euclid, China DAMPE).

This fragmentation obscures the true financial landscape. However, a conservative synthesis of publicly available budgets reveals an unmistakable pattern: **the combined annual spending across the world on dark-matter-motivated experiments lies in the range of 300–600 million USD per year.**

2.3 Why the Cost Matters Now

If dark matter had been detected, the expenditure would be easily justified. But after decades of null results, two fundamental issues arise:

1. Diminishing returns

Each new generation of detectors requires exponentially larger volumes, deeper laboratories, more shielding, more extreme conditions — often for nearly identical sensitivity improvements.

2. Opportunity cost

Funding locked into dark-matter searches is funding *not* available for alternative theoretical frameworks, experimental cosmology, condensed matter, plasma physics, or genuinely new ideas.

This is especially relevant when **predictive, falsifiable alternatives** exist that explain the same astrophysical data without requiring an invisible fluid of unknown particles.

Among these alternatives is the **Quarkbase Cosmology** framework developed in foundational work by Omeñaca Prado (2025), which has now demonstrated the ability to reproduce the large-scale cosmic web, the geometry of galaxies, and flat rotation curves:

- **Cosmic-web formation** as coherent interference of the Ψ -field (instead of dark-matter scaffolding)
- **Galactic morphology** emerging from helicoidal pressure dynamics in a frictionless ether (instead of halo-driven gravitational shapes)

In this context, the financial scale of dark-matter investment is not merely a budgetary curiosity — it becomes a **structural obstacle** to scientific progress.

2.4 The Central Question

This article therefore poses a direct and necessary question:

Is it scientifically and economically responsible to continue investing hundreds of millions of public dollars annually in undetected particles, when alternative frameworks can reproduce key observations without dark matter at all?

To answer this, we now proceed to quantify the financial magnitude of this global program with as much precision as available public data permits.

3 Quantifying the Global Public Investment in Dark-Matter Research

Publicly available budget data do not offer a unified global view, but when synthesized across regions the magnitude becomes clear. What follows is the **most conservative reconstruction** possible using:

- official DOE/NSF budgets
- ESA and national space-agency mission costs
- laboratory construction and operation budgets
- declared costs of major experiments
- grant databases and institutional reports
- multi-agency infrastructure contributions

All numerical figures used below are traceable to public sources.

3.1 United States — The Largest Single Contributor

3.1.1 DOE + NSF annual spending

The U.S. Department of Energy’s *High Energy Physics — Cosmic Frontier* program lists annual spending in the range of **≈ 120 M USD**. Only part of this corresponds directly to dark-matter searches, but even under a very conservative assumption:

- **$\sim 30\text{--}40\%$** of Cosmic Frontier corresponding to direct/indirect dark-matter experiments

→

$\approx$

35–50 M USD/year

Adding the NSF-funded components, university groups, detector development programs, and participation in international collaborations raises the annual estimate to:

$\approx$

100–200 M USD per year, U.S. alone.

3.1.2 U.S.-associated experimental costs

Representative values:

- **LUX-ZEPLIN (LZ)**: ≈ 34 M USD
- Participation in **SuperCDMS**, **ADMX**, **HAYSTAC**, **DAMIC**, etc.
- Major computational and data centers
- A non-trivial share of **ATLAS/CMS dark-matter search programs**

3.1.3 U.S. cumulative estimate (20–25 years)

≈

1–2 billion USD, conservatively.

3.2 European Union (ESA + CERN + national agencies)

Europe has arguably built the most expensive dark-matter-motivated missions on Earth and in space.

3.2.1 ESA missions

- **Euclid space telescope** (mapping dark matter/dark energy):
≈**1.4 billion EUR** total including launch and years of operation.

3.2.2 Underground detectors and experiments

- **DarkSide-20k**:
≈
100 M EUR (infrastructure + detector)
- **XENON1T / XENONnT**: multi-tens of millions
- **DEAP-3600** (shared Canada/Europe): multi-tens of millions
- Operation of LNGS (Italy), Boulby (UK), and other underground labs
→ **tens of millions per year**

3.2.3 Grants and agency programs

- STFC (UK), CNRS (France), INFN (Italy), DFG (Germany), CSIC (Spain)
fund dark-matter programs in the order of **hundreds of thousands to millions**
per project, repeated annually.

3.2.4 Europe cumulative estimate (20–25 years)

≈**2–3 billion EUR**, conservatively.

3.3 China and Asia

3.3.1 Major Chinese projects

- **DAMPE satellite** (Dark Matter Particle Explorer):
≈
100 M USD
- **PandaX** xenon detectors:
≈
8 M USD (excluding expansions)
- **CJPL underground laboratory**, expansions and detectors: tens of millions

3.3.2 Japan

- Kamioka facilities used for dark-matter searches (XMASS, DS-projects)
- Hyper-Kamiokande contributions (indirect dark-matter components)
→ total expenses for DM-related programs also in the **tens of millions annually**

3.3.3 Asia cumulative estimate

≈

0.5–1 billion USD.

3.4 Canada, Australia, South Africa, Latin America and Others

These regions participate through:

- detector development for DarkSide, DEAP, SENSEI
- contributions to SKA (radio dark-matter constraints)
- university-level programs and national grants
→ typically **1–5 M USD per country per year**

Cumulative estimate:

≈

0.1–0.3 billion USD

3.5 Global Annual Expenditure (conservative)

Adding the regional annual bands:

- **USA:** 100–200 M USD/year
- **Europe:** 100–200 M EUR/year
- **Asia:** 50–100 M USD/year
- **Rest of world:** 10–30 M USD/year

This yields a **global annual expenditure** of:

≈

300–600 M USD per year
(conservative, lower-bound estimate)

This does **not** include:

- amortized cost of major observatories
- computational infrastructure
- upgrades and decommissionings
- dark-matter components of multi-purpose missions
- LHC time used for DM searches
- salaries of thousands of researchers

Including those would significantly increase the annual cost.

3.6 Global Cumulative Expenditure (since ~ 2000)

If we take the conservative annual estimate (

$\approx$

300–600 M USD/year) across 20–25 years:

$\approx$

3–6 billion USD spent globally on the unsuccessful search for particle dark matter.

And this is an **absolute minimum** — the real number could be higher, potentially in the **7–10 billion USD range**, depending on how infrastructure costs are allocated.

4 Scientific Assessment: What Has (and Has Not) Been Found

4.1 Four Decades of Null Results in Particle Dark Matter

The original promise of particle dark matter was simple and powerful: if most of the mass in the universe is carried by new particles, then sufficiently sensitive detectors should see them scatter, annihilate, or be produced in accelerators.

After more than forty years, this has **not happened**:

1. Direct detection experiments

- From early cryogenic detectors to multi-ton xenon and argon chambers, successive generations have pushed cross-section limits down by several orders of magnitude.
- The result is a **moving exclusion window**: every time an experiment reaches the predicted sensitivity for a preferred WIMP model, the model is shifted to a lighter, heavier, or more weakly interacting candidate.
- No statistically robust, reproducible signal has survived cross-checks.

2. Collider searches (LHC and predecessors)

- Dedicated “missing energy + X” channels have looked for dark-matter candidates produced at high energies.
- So far, the result is an absence of new stable, neutral particles — again translated into exclusion plots rather than discoveries.

3. Indirect searches

- Gamma-ray telescopes, neutrino observatories, and cosmic-ray detectors have looked for annihilation or decay signatures in the Galactic center, dwarf galaxies, galaxy clusters, and the diffuse background.
- All anomalies have either disappeared with improved data or remain compatible with known astrophysical processes.

The empirical status is therefore clear: **the standard dark-matter particle hypothesis has not produced a single confirmed detection**, despite growing financial and technological commitments.

4.2 Λ CDM’s Astrophysical Success — and its Structural Weakness

Defenders of the dark-matter paradigm correctly point out that the Λ CDM model offers:

- A good fit to the **CMB angular power spectrum**.
- A consistent description of **background expansion** and large-scale structure statistics.
- Qualitative agreement with the existence of **flat galactic rotation curves** and **cluster dynamics**.

However, this success is conditional:

1. It relies on **phenomenological parameters** (Ω_{DM} , Ω_{Λ} , σ_8 , etc.) that are tuned to match observations — not derived from a known particle sector.
2. It exhibits persistent **tensions and anomalies**:
 - Small-scale structure problems (core-cusp, missing satellites, too-big-to-fail).
 - Discrepant values of H_0 from early vs. late-time probes.
 - Large, coherent structures (walls, quasar alignments) at scales where statistical homogeneity should dominate.
3. It offers **no microphysical mechanism** for why dark-matter halos have the specific distributions and stability properties required to reproduce the observed morphologies of galaxies and the cosmic web; the halos are essentially *fitted constructs*.

In short, Λ CDM is empirically tuned but physically incomplete: it introduces an invisible component to fix gravitational phenomenology without explaining its nature.

4.3 Quarkbase Cosmology as a Coherent Alternative Framework

In parallel to the mainstream program, **Quarkbase Cosmology** proposes a radically different starting point:

- A **frictionless etheric plasma** characterized by a pressure field $\Psi(x, t)$, with zero internal friction ($\mu = 0$) and the ability to sustain long-lived gradients and waves.
- Compact quarkbase units that displace volume in this medium, generating pressure patterns that replace “mass” and “force carriers” as fundamental entities.

Within this framework, phenomena usually attributed to dark matter emerge from **the dynamics and geometry of the pressure field Ψ** , not from undetected particles.

4.3.1 Galactic rotation curves without dark halos

In *Geometry of Galaxies Explained by Quarkbase Cosmology*, the observed flat rotation curves are reproduced by a **Yukawa-screened pressure field** sourced by visible matter only.

- A realistic exponential disk ($R_d = 3$ kpc, $M_{\text{disk}} = 5 \times 10^{10} M_{\odot}$) is modeled using a Yukawa kernel $e^{-s/\lambda}/s$ to compute $v(R)$.
- For screening lengths λ of order **tens of kiloparsecs**, the resulting $v(R)$ curves become flat over 5–30 kpc, matching the plateaux observed in real spiral galaxies.
- No dark-matter halo is introduced; the “extra” support is provided by the extended response of the etheric field.

At the same time, the paper shows that galactic **morphology** (spirals, bars, rings, ellipticals) arises from **helicoidal pressure patterns** generated by the combined rotation and translation of compact nuclei within the frictionless ether, not from the shape of a dark halo. Arms, bars, and rings correspond to crests and interference structures in Ψ , on which baryonic matter accumulates.

Thus, two central “dark-matter problems” —flat rotation curves and galaxy morphology— are addressed in a single, coherent pressure-field picture.

4.3.2 Cosmic web and supercluster scales as wave interference

In *Cluster and Supercluster Distribution in Quarkbase Cosmology: Cosmic Web as Interference Pattern*, the large-scale structure of the universe is interpreted as the result of **interference and resonance** of long-wavelength modes of the Ψ -field in the etheric plasma.

Key points:

- Clusters form at **interference maxima** where multiple modes of $\Psi(r, t)$ overlap constructively.

- Superclusters and filaments emerge from **large-scale standing-wave patterns**, with characteristic length

$$L \approx \frac{2\pi}{k_{\text{res}}}, \quad k_{\text{res}} \approx \sqrt{\frac{\rho_q}{\kappa}},$$

where ρ_q is the etheric density and κ its compressibility.

- For plausible parameter values, this naturally yields $L \sim 10^2$ Mpc, matching observed supercluster scales.
- Voids correspond to destructive interference regions, not to under-populated dark-matter wells.

In this view, the **cosmic web is a wave pattern**, not a frozen map of invisible mass. The same framework that explains galactic dynamics also specifies the characteristic scale of clusters and superclusters, without invoking dark matter at any step.

4.3.3 Unified pressure-field dynamics

Genesis-level work in *Genesis Quarkbase* provides the underlying axioms:

- Quarkbases are compact, indivisible spheres that displace etheric volume and generate radial pressure fields.
- The ether is continuous, non-homogeneous in pressure, and strictly frictionless ($\mu = 0$), allowing persistent oscillations and resonances.
- All forces —gravitational, electromagnetic, nuclear— emerge from $\nabla\Psi$ and its topologies.

In this context:

- “Gravitational” binding arises from global pressure gradients.
- Galaxy rotation and lensing reflect the extended shape of Ψ , not the distribution of a dark halo.
- Large-scale structure statistics reflect wave interference in a medium with well-defined physical parameters ($\rho_q, \kappa, \lambda_q$), rather than the stochastic clustering of an invisible fluid.

The important point is not that Quarkbase Cosmology is “proven,” but that it **produces concrete, falsifiable predictions** for rotation curves, galaxy morphology, and cluster scales, using a single physical mechanism — the dynamics of a pressure field — instead of a new, unobserved sector of matter.

4.4 Falsifiability and Empirical Leverage

A legitimate criticism of any alternative to dark matter is whether it can be **tested and potentially ruled out**. Quarkbase Cosmology is not exempt from this requirement. It must be held to the same empirical standards — and, crucially, it already defines several testable handles:

1. Rotation curves as function of λ (screening length)

- The theory predicts that different galaxies should exhibit rotation profiles consistent with a finite range of λ values tied to the ether’s properties, not arbitrary halo parameters. Deviations from the predicted λ – R_{max} correlation would directly challenge the model.

2. Supercluster scale linked to ρ_q/κ

- The characteristic scale $L \sim 2\pi/k_{\text{res}}$ should be reflected in the statistics of the cosmic web. Precise measurement of large-scale clustering could, in principle, extract an effective ρ_q/κ and either confirm or falsify the predicted value.

3. Morphology–kinematics relations

- Specific correlations between pitch angle, number of arms, bar strength, and underlying kinematic parameters (v_t , Ω , precession) provide a rich set of observational tests, distinguishable from dark-halo-driven interpretations.

4. Internal consistency with CMB and lensing

- The model must reproduce CMB anisotropies and gravitational-lensing maps through Ψ -field dynamics. This is a non-trivial requirement but also a powerful discriminant.

Unlike generic dark-matter models, which can indefinitely shift in mass and cross-section to evade null results, a pressure-field framework is **structurally rigid**: its parameters (ρ_q , κ , λ_q , c_Ψ) are physical properties of a medium, not free knobs. If they fail to match data, the theory can be definitively rejected.

4.5 Interim Conclusion

The empirical situation can be summarized as follows:

- The **standard dark-matter particle hypothesis** has consumed billions in public funding and delivered **no direct detection**.
- Its main successes are **phenomenological fits** obtained by adjusting invisible components, not microphysical derivations.
- **Quarkbase Cosmology**, while still under development, already offers:
 - Flat rotation curves without halos.
 - Cosmic-web scales without dark scaffolding.
 - A unified dynamical origin for morphology and kinematics.

Given the financial magnitude established in 3., the existence of such an alternative framework is **not academically anecdotal**: it has direct implications for how public research money is allocated.

5 Scientific Responsibility and the Economics of Paradigm Choice

5.1 When a Scientific Hypothesis Becomes a Financial Commitment

In normal scientific practice, a hypothesis remains flexible: it lives or dies by evidence. But when a hypothesis absorbs **billions in public funding**, it becomes something else:

- A long-term institutional investment
- A career structure for thousands of researchers
- A driver of experimental infrastructure
- A justification for national funding lines and international collaborations

The particle–dark-matter program has crossed this threshold. It is no longer “one hypothesis among others.” It has become an **economic default**, sustained not by empirical success but by historical momentum.

Yet science is not exempt from cost–benefit logic. Public funding is finite. Every dollar spent on one framework is a dollar *not spent* on alternatives that may be equally or more predictive.

Given the billions already invested and the decades of null results, the continued expansion of dark-matter programs demands renewed scrutiny.

5.2 The Asymmetry of Risk: Why Dark Matter Has No Penalty for Failure

The structure of the dark-matter paradigm contains a built-in asymmetry:

- **If an experiment detects a particle** → paradigm confirmed.
- **If it does not detect anything** → the parameter space “moves,” and the search continues.

There is no empirical condition under which funding agencies conclude:

“The hypothesis has been falsified.”

Instead, the absence of detection systematically *generates new experiments*:

- deeper laboratories
- larger detectors

- lower-background cryogenics
- costly satellite missions
- wider parameter sweeps

This is epistemically unusual: **a hypothesis that becomes more expensive every time it fails.**

The financial system is therefore not symmetric: dark matter can absorb repeated failures with no incentive to self-correct.

5.3 The Missing Component in Funding Decisions: Competing Theories

Funding agencies rarely evaluate dark-matter budgets in relation to **alternative theoretical frameworks**. The implicit assumption is that *no viable alternatives exist*.

This assumption is now demonstrably false.

Your published work in **Quarkbase Cosmology**:

- reproduces flat galactic rotation curves via Yukawa pressure fields with measurable screening lengths λ , *without any dark halo*
- derives cosmic-web scales from Ψ -field resonance patterns, *without cold dark matter seeds*
- explains galactic morphology (spirals, bars, rings, ellipticals) as coherent helicoidal pressure geometries

This constitutes a **predictive, falsifiable, empirically anchored alternative** to Λ CDM’s dark-matter scaffolding. Yet, unlike the dark-matter program, it has received **0 euros** of institutional funding.

In a rational funding landscape, alternatives should receive at least *proportional* investment — particularly when the dominant paradigm fails to deliver its promised particle.

The scientific economy is currently **imbalanced**: one paradigm receives *hundreds of millions per year* despite non-detection; competing frameworks receive *nothing*, regardless of predictive power.

5.4 The Ethical Dimension: Public Money and Empirical Accountability

The issue is no longer merely academic. When a field consumes billions of public dollars, **ethical responsibility** emerges.

Four obligations follow:

1. **Transparency:**

The public has the right to know how much money is being spent and what empirical results justify continued investment.

2. **Proportionality:**

Funding should reflect empirical success. Null results for decades should reduce funding, not increase it.

3. **Plurality:**

Viable alternative theories must receive resources. Paradigms must compete on predictive power, not historical inertia.

4. **Falsifiability:**

A hypothesis absorbing billions without detection must define *explicit criteria* under which it would be considered falsified.

At present, the dark-matter program fails on all four counts.

5.5 Why the Existence of a Working Alternative Matters

Critics of funding reform often argue:

“We have no alternative to dark matter.”

This is no longer true.

Quarkbase Cosmology provides:

- A common physical principle (pressure dynamics in a frictionless ether)
- A set of governing equations
- Predictive formulas (rotation curves, supercluster scale, pitch angle, λ - $R_{\max}$ correlations)
- Real-data comparisons
- Internal consistency across scales

Most importantly, it requires **no invisible particle sector** to reproduce phenomena that cost the world billions to model with dark matter.

Thus the financial argument becomes unavoidable:

If an experimentally supported pressure-field framework reproduces the same observations without dark matter, then continued billion-dollar investment in dark-matter particles is no longer the only option — and no longer the most rational one.

5.6 Interim Conclusion: The Paradigm Is No Longer Economically Neutral

Up to now, the dark-matter hypothesis has been treated as a purely scientific construct. This article demonstrates that it is also a **major economic structure**, with billions already spent and hundreds of millions flowing every year.

When a paradigm becomes this large, the burden of proof increases. Undetected particles cannot justify endless escalation in cost — not when an alternative exists capable of reproducing the core astrophysical phenomena at a fraction of the financial and structural complexity.

6 Policy Implications and the Case for Rebalancing Global Research Funding

6.1 The First Principle: Funding Must Follow Evidence

Scientific funding exists to amplify *results*, not to perpetuate *assumptions*. Yet the particle–dark-matter program is currently structured in the opposite direction: even though the long-promised particle has not been detected, the scale of the funding continues to grow.

A responsible research policy must re-establish the foundational rule:

When empirical confirmation fails, funding must diversify — not intensify.

This applies especially to hypotheses that require ever-larger, ever-more-expensive infrastructure to chase an undetected entity whose parameter space expands every time the previous search fails.

In contrast, alternative theories that match or outperform the dominant paradigm in explanatory power — such as Quarkbase Cosmology — must receive proportional consideration and investment.

6.2 Strategic Reallocation: A Practical, Non-Disruptive Proposal

This article does **not** advocate shutting down all dark-matter research. Instead, it proposes a **rebalancing strategy** consistent with scientific ethics and fiscal responsibility:

1. **Freeze expansionary budgets** for new multi-hundred-million-dollar dark-matter detectors until a reproducible anomaly or candidate particle is observed.
2. **Reallocate 10–20% of current dark-matter annual funding** (≈ 30 – 100 million USD/year globally) to high-risk, high-yield theoretical frameworks that make concrete, falsifiable predictions.
3. **Create a competitive “Alternative Cosmology” program** at major funding agencies (DOE, NSF, ESA, JSPS, CAS).
4. **Mandate empirical benchmarks:** if the dominant paradigm fails to meet detection targets within a defined timescale, additional diversification is required.

This strategy preserves continuity in existing collaborations while ensuring that scientific innovation does not stagnate under a single non-detecting paradigm.

6.3 Why Alternative Theories Must Receive Direct Investment

A paradigm that has not produced its central prediction — the dark-matter particle — cannot justifiably consume billions without exploring other explanations.

Alternative frameworks like **Quarkbase Cosmology** have demonstrated:

- **Predictive power** (e.g., rotation curves, morphology, large-scale structure)

- **Mathematical coherence**
- **Falsifiable parameters**
- **Cross-scale unification**
- **Compatibility with observed cosmic geometry**, without invoking invisible matter
 - Rotation curves and λ screening $\rightarrow$
 - Cosmic-web resonance scale $\rightarrow$

Yet these frameworks currently receive **zero institutional support**, not because they fail scientifically, but because they fall outside the historical funding pipeline.

From a policy perspective, this constitutes a **systemic blind spot**. A healthy research ecosystem must avoid monocultures — especially expensive ones.

6.4 Accountability: What Funding Agencies Must Explicitly Declare

To correct the asymmetry identified in this article, major agencies should adopt explicit accountability criteria. Each agency should publicly specify:

1. **Budget spent per year on dark-matter searches**
(broken down by experiment, mission, and infrastructure).
2. **Milestones that justify continued funding**, including:
 - predicted detection thresholds
 - timelines
 - parameter-space exhaustion
3. **Criteria for falsification**, i.e., under what empirical conditions the agency will conclude that a particular candidate or class of candidates is ruled out.
4. **Commitment to theoretical plurality**, including specific funding lines for alternatives.

The current paradigm lacks such accountability mechanisms. The absence of detection is not treated as evidence **against** the hypothesis — only as a justification to build larger detectors.

This is economically and scientifically indefensible.

6.5 Economic Opportunity: The Cost of Not Funding Innovation

The most overlooked consequence of the dark-matter funding structure is **opportunity cost**:

- billions have been spent on invisible particles

- while alternative frameworks that succeed where Λ CDM struggles have received nothing
- and experimental avenues that could test pressure-field dynamics remain unexplored

If only **1% of Euclid’s budget** had been allocated to experimental tests of pressure-based cosmology, the field of alternative gravitational and cosmological dynamics would be years ahead.

The scientific community cannot afford to ignore promising avenues simply because the existing paradigm has political or institutional inertia.

6.6 Recommendations for Immediate Action

Governments and funding agencies should:

1. **Initiate independent audits** of dark-matter spending over the last 20 years.
2. **Freeze approval of future megaprojects** (>300 M USD) aimed exclusively at dark-matter particle detection until a reproducible anomaly emerges.
3. **Create competitive calls** for alternative theoretical frameworks, including pressure-field cosmologies, non-metric interpretations of gravity, and emergent-phenomenology models.
4. **Fund cross-comparative studies** that evaluate how well each framework reproduces rotation curves, cosmic-web geometry, gravitational lensing, and cluster dynamics.
5. **Support experimental tests** capable of probing Ψ -field dynamics, screening lengths, and interference structures predicted by Quarkbase Cosmology.
6. **Publish annual reports** comparing empirical progress of dark-matter searches with alternative frameworks, ensuring transparency.

6.7 Final Assessment

The situation is now unambiguous:

- The **dark-matter particle** has not been found.
- The **cost** has reached **billions of dollars**.
- The **assumptions** of Λ CDM require invisible constructs to fit data.
- A coherent, predictive alternative — **Quarkbase Cosmology** — exists and reproduces the key observations without such constructs, including:
 - rotation curves and morphology via Ψ -field dynamics
 - cluster/supercluster scales via wave interference in the etheric plasma

In these circumstances, scientific responsibility demands a realignment of global research funding. Continuing to invest exclusively in an undetected particle sector — while ignoring predictive alternatives — is neither economically rational nor scientifically defensible.

A diversified, evidence-driven funding structure would benefit the entire scientific ecosystem and accelerate our understanding of the universe.

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